

BIO-IMAGING BEAMLINES AT NSLS-II

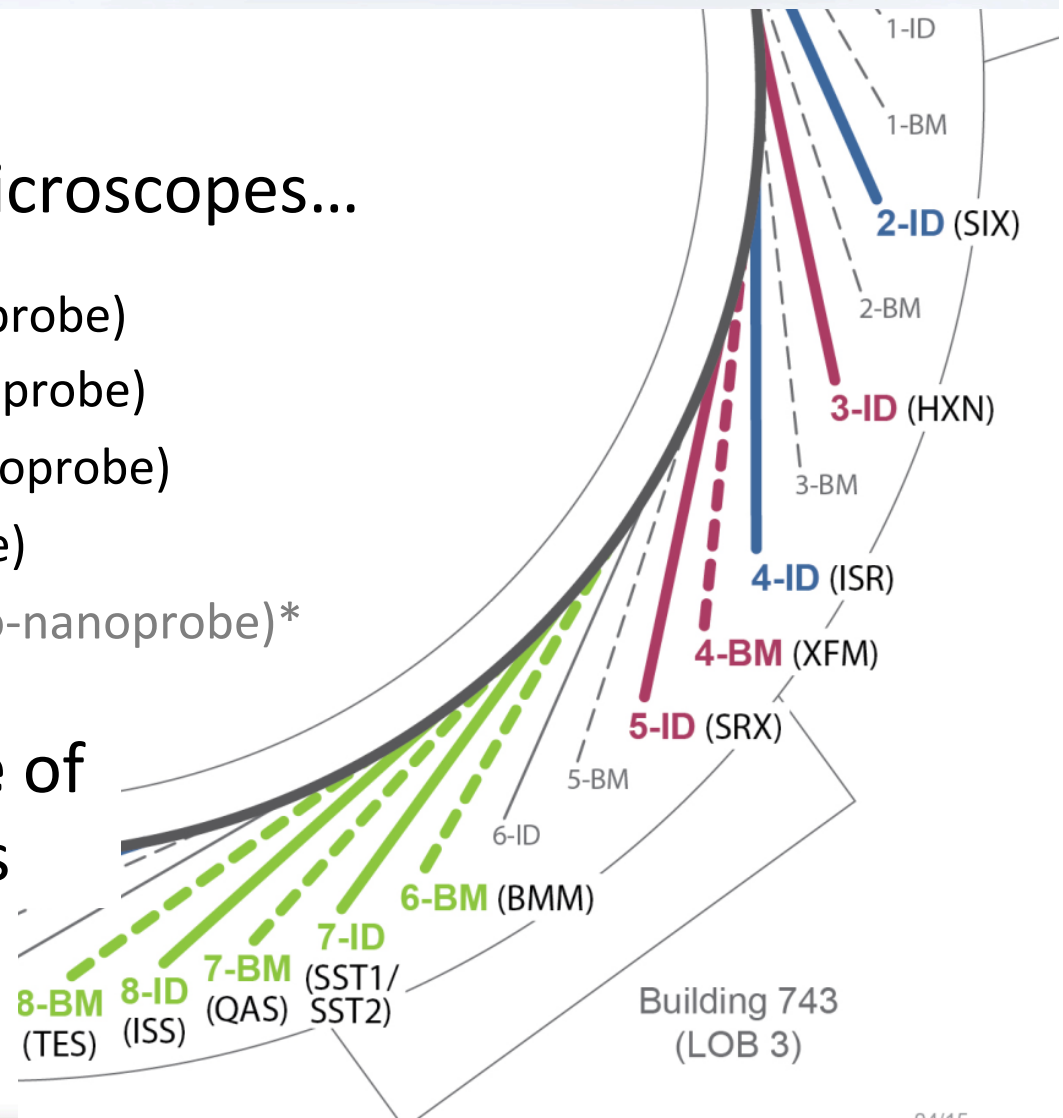


Family of Bio-imaging Beamlines at NSLS-II

X-ray fluorescence microscopes...

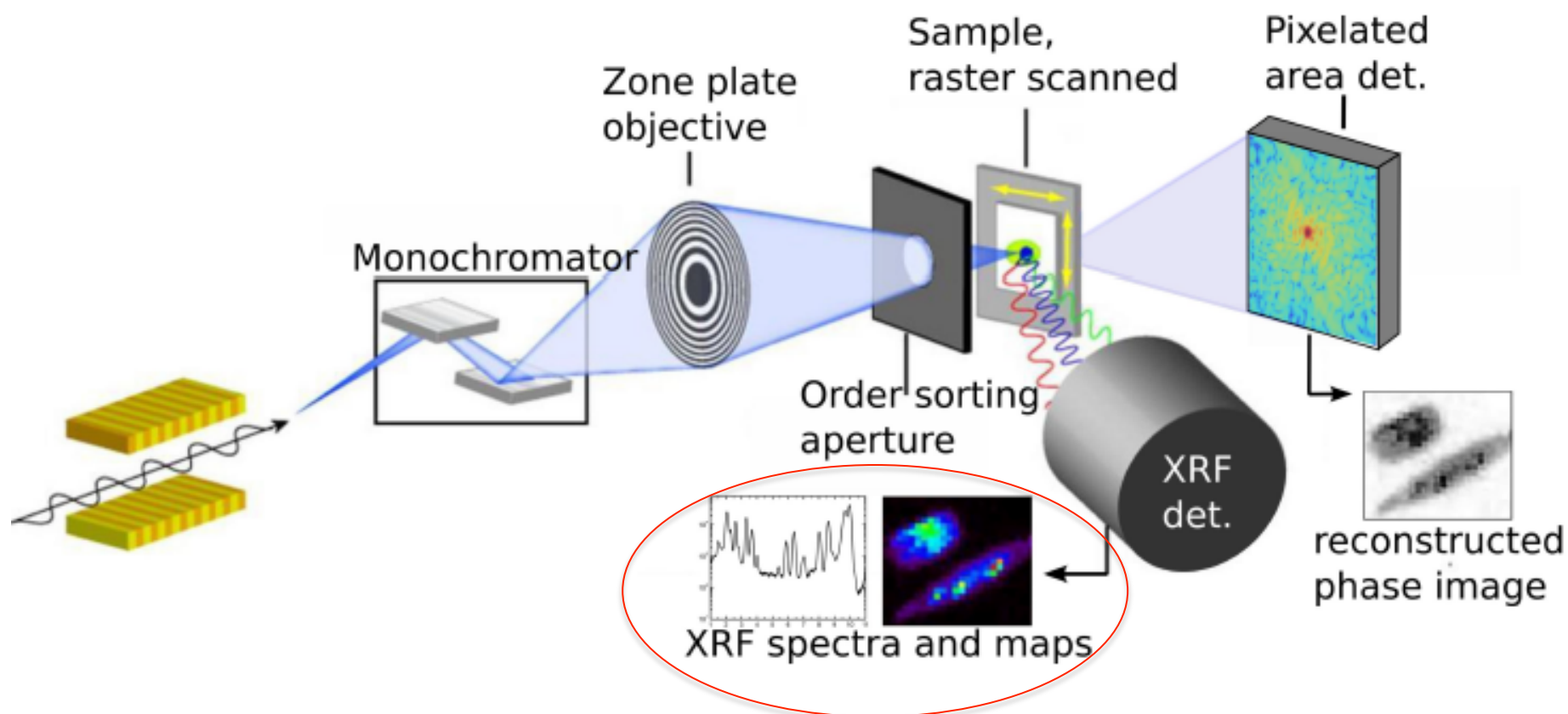
- HXN (Hard X-ray nanoprobe)
- SRX (Sub-micron X-ray probe)
- TES (Tender X-ray microprobe)
- XFM (X-ray microprobe)
- XFN (Tender X-ray cryo-nanoprobe)*

...to cover a **broad range** of energy and spatial scales



*planning stage

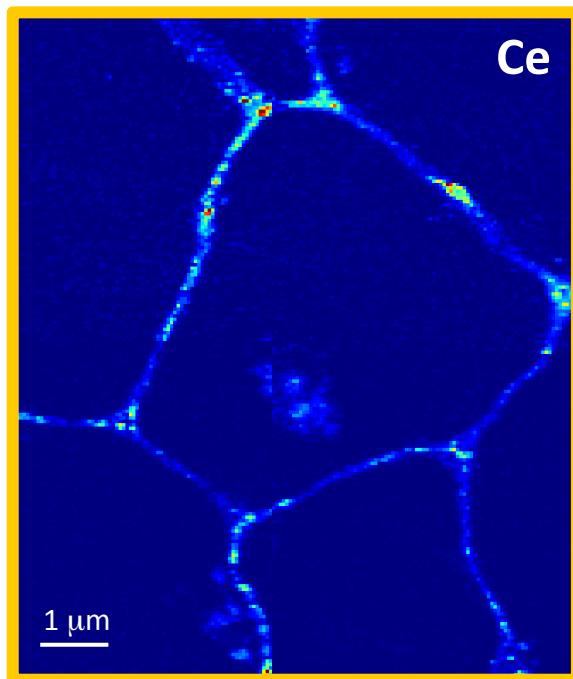
GENERIC X-RAY MICROSCOPE



Chen et al., *SPIE* 9592: 959201–6 (2015)

HARD X-RAY NANOPROBE (HXN)

Mission : HXN is designed and constructed to explore new frontiers of hard X-ray microscopy applications with the highest achievable spatial resolution



Apoplastic distribution of nano-CeO₂ in root cortex

Experimental Capabilities:

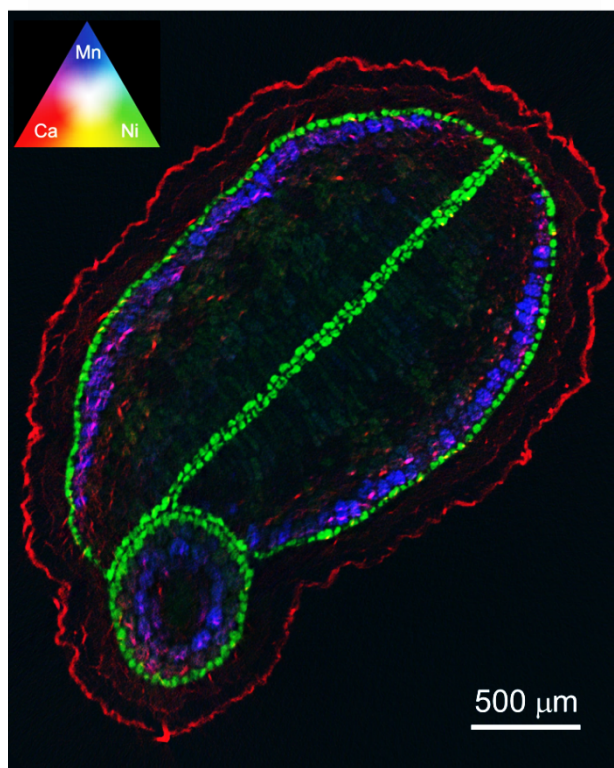
	Absorption-, phase-, and XRF-contrast imaging
	Nanodiffraction
	Chemical-state mapping
	Ptychography

Specifications:

Energy range	6 – 25 keV
Spot size	10 nm (goal: 1 nm)
Flux	10 ⁸ ph/s (@10 keV)
Energy resolution	10 ⁻⁴ ($\Delta E/E$)
Source	IVU20
Operational	May 2015

X-RAY FLUORESCENCE MICROPROBE (XFM)

Mission: XFM is a versatile X-ray microprobe optimized for spatially-resolved EXAFS spectroscopy and imaging at the micrometer scale



Localization of Ca, Ni and Mn
in seed of agro-mining crop

Experimental Capabilities:

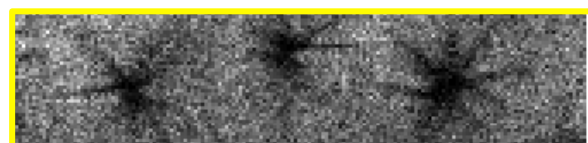
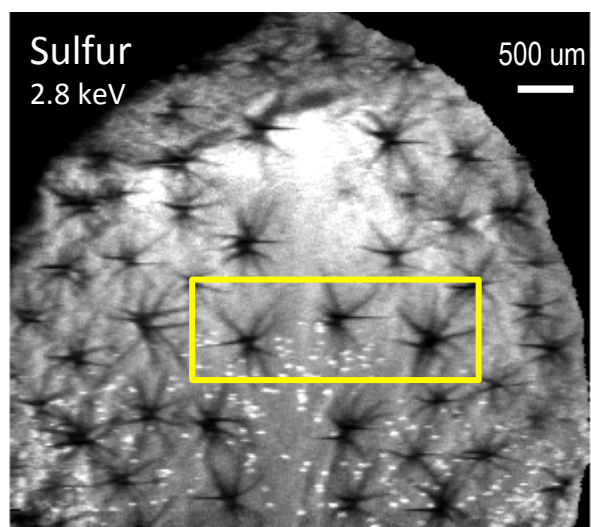
	X-ray absorption spectroscopy (μ XANES & μ EXAFS)
	X-ray fluorescence imaging (μ XRF)
	Fluorescence microtomography (fCMT)
	X-ray microdiffraction (μ XRD)

Specifications:

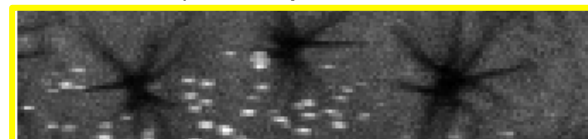
Energy range	2 – 23 keV
Spot size	~1 micron
Flux	$\sim 10^{11}$ ph/s
Energy resolution	10^{-4} ($\Delta E/E$)
Source	Wiggler (3PW)
Operations	Fall 2017

TENDER ENERGY SPECTROSCOPY (TES)

Mission: Tender-energy X-ray imaging and spatially-resolved extended X-ray absorption fine structure spectroscopy in diverse scientific fields



2473.3 eV (sulfide)



2482.0 eV (sulfate)

Experimental Capabilities:

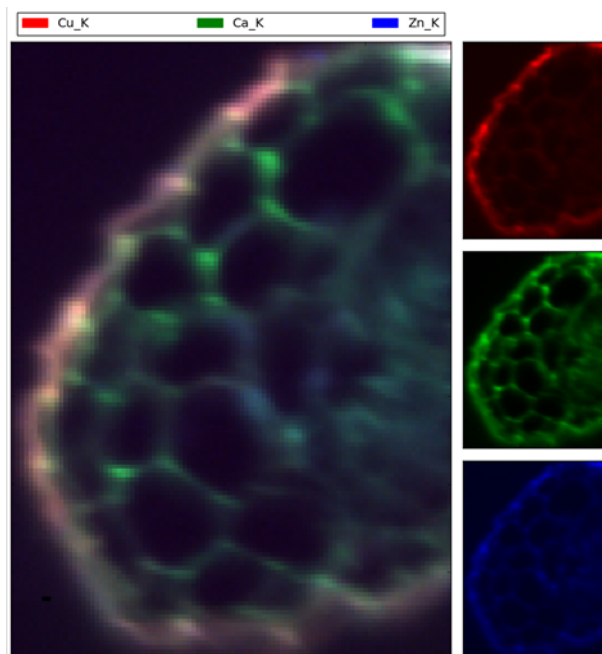
	Tender X-ray fluorescence imaging	
	Spatially- resolved EXAFS and XAS imaging	
	<i>In-Situ</i> and <i>in-Operando</i> XAS	
	Bulk EXAFS	

Specifications:

	Energy range	1 – 5 keV
	Spot size	2-20 micron (to 1mm)
	Flux	$\sim 10^{12}$ ph/s
	Energy resolution	10^{-4} ($\Delta E/E$)
	Source	Bend Magnet (BM)
	Operations	Fall 2016

SUB-MICRON RESOLUTION X-RAY PROBE (SRX)

Mission: SRX is designed for sub-micron resolution X-ray fluorescence imaging and spectro-microscopy.



Localization of Cu, Ca and Zn in root of pine tree

Experimental Capabilities:

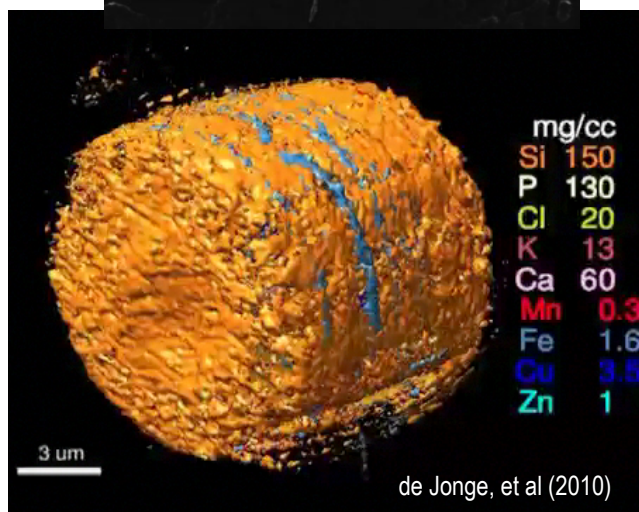
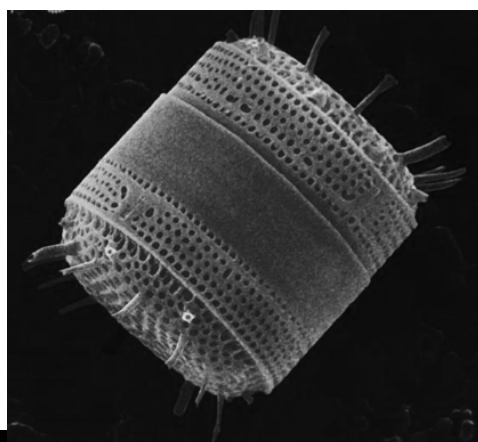
X-ray Fluorescence Imaging
X-ray Tomography (full field and fCMT)
X-ray Absorption Near Edge Structure Spectroscopy
Chemical-state mapping

Specifications:

Energy range	4.7 – 25 keV
Spot size	sub-100 nm; 500 nm
Flux	$\sim 10^{13}$ ph/s (@12 keV)
Energy resolution	10^{-4} ($\Delta E/E$)
Source	IVU21
Operational	May 2015

X-RAY FLUORESCENCE CRYO-NANOPROBE (XFN)

Mission: XFN is optimized for biological and environmental sciences and designed for nano-scale 2-D and 3-D imaging of frozen-hydrated samples



Experimental Capabilities:

	X-ray fluorescence imaging (XRF)	
	Fluorescence microtomography (fCMT)	
	X-ray phase contrast imaging and tomography	
	X-ray absorption spectroscopy (XANES)	

Specifications:

	Energy range	2 – 12 keV
	Spot size	30 nm; 100 nm
	Flux	$\sim 10^{10}$ ph/s (@10 keV)
	Energy resolution	10^{-4} ($\Delta E/E$)
	Source	IVU
	Projected operations	2019

WEBLINKS

<http://www.bnl.gov/ps/beamlines/beamline.php?b=XFM>

<http://www.bnl.gov/ps/beamlines/beamline.php?b=TES>

<http://www.bnl.gov/ps/beamlines/beamline.php?b=HXN>

<http://www.bnl.gov/ps/beamlines/beamline.php?b=SRX>